इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS/QC 440000 (1994): Directly Heated Positive Step - Function Temperature Coefficient Thermistors - Generic Specification [LITD 5: Semiconductor and Other Electronic Components and Devices]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

IS QC 440000 : 1994
IEC QC 440000 : 1982

(Reaffirmed 2002)

भारतीय मानक

प्रत्यक्ष तापित घनात्मक पदक्रम फलन तापमान गुणांक थर्मिस्टर — जातिगत विशिष्टि

Indian Standard

DIRECTLY HEATED POSITIVE STEP-FUNCTION TEMPERATURE COEFFICIENT THERMISTORS — GENERIC SPECIFICATION

UDC 621·316·825·2

© BIS 1994

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

February 1994

Price *Rs* 140.00

Indian Standard

DIRECTLY HEATED POSITIVE STEP-FUNCTION TEMPERATURE COEFFICIENT THERMISTORS — GENERIC SPECIFICATION

NATIONAL FOREWORD

This Indian Standard, which is identical with IEC Pub 738-1/QC 440000 (1982) 'Directly heated positive step function temperature coefficient thermistors – Part 1 : Generic specification', issued by the International Electrotechnical Commission, was adopted by the Bureau of Indian Standards on the recommendation of the Resistors Sectional Committee (LTD 14) and approval of the Electronics and Telecommunication Division Council.

The text of the IEC standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards are for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

International Standards	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC Pub QC 001001 : 1986 Basic rules of the IEC quality assessment system for electronic components (IECQ)	IS QC 001001 : 1988 Basic rules of the IEC quality assessment system for electronic components (IECQ)	Identical
IEC Pub QC/001002 : 1986 Rules of procedure of the IEC quality assessment system for electronic components (IECQ)	IS QC 001002 : 1988 Rules of procedure of the IEC quality assessment system for electronic components (IECQ)	Identical
IEC Pub 294 : 1969 Measurement of the dimensions of a cylindrical component having two axial terminations	IS 13554 : 1992 Measurement of the dimensions of a cylindrical component having two axial terminations	Identical

The concerned technical committee has reviewed the provision of IEC 62 (1974), IEC 63 (1963), IEC 68 and IEC 410 (1973), referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard.

This standard is intended primarily for use under the IECQ System. A regular Indian Standard for this component could be different, identical or similar to this standard.

Only the English Language text in the International Standard has been retained while adopting it in this Indian Standard.

As in the Original Standard, this Page is Intentionally Left Blank

INTRODUCTION

The present standard covers "directly heated positive step-function temperature coefficient thermistors".

This designation applies to thermally sensitive resistors, whose resistance increases substantially with increasing temperature, at least within a specified range of temperature. They are generally intended for applications where a considerable change of resistance is required as a function of temperature, or of dissipated power, for example:

— Temperature indication, control or alarm.

— Compensatory circuits.

— Time-delay of relays.

— Circuit protection.

— Indication, measurement or detection of fluid levels, flow, etc.

SECTION ONE — GENERAL

1. Scope

This standard is applicable to directly heated positive temperature coefficient thermistors, insulated or non-insulated, having a resistance temperature characteristic which approximates to a step-function. Typically they are made of ferro-electric semi-conductive materials.

2. Object

The object of the present standard is to:

— define the terminology for the thermistors covered by this standard;
— specify the conditions for approval, acceptance and continuous quality control;

— define the methods of test.

3. Related documents

This standard shall be used in conjunction with other IEC Publications, such as:

Publication 62: (1974)	Marking Codes for Resistors and Capacitors.
Publication 63: (1963)	Preferred Number Series for Resistors and Capacitors.
Publication 68:	Basic Environmental Testing Procedures.
Publication 294: (1969)	Measurement of the Dimensions of a Cylindrical Component Having Two Axial Terminations.
Publication 410: (1973)	Sampling Plans and Procedures for Inspection by Attributes.
Publication QC 001001: (1981)	Basic Rules of the IEC Quality Assessment System for Electronic Components (IECQ).
Publication QC 001002: (1981)	Rules of Procedure of the IEC Quality Assessment System for Electronic Components (IECQ).

4. Terminology

4.1 *Directly heated positive step-function temperature coefficient thermistor (PTC-S)*

A thermally sensitive semi-conductor resistor, which shows a step-like increase in its resistance when the increasing temperature reaches a specific value.

The change in temperature is obtained either by the flow of current through the thermosensitive element, or by a change in the ambient temperature, or by a combination of both these means. A PTC-S thermistor may show secondary effects which have to be taken into account (see Sub-clauses 4.20 and 4.21).

4.2 *Zero-power resistance* (R_T)

The d.c. resistance value of a thermistor measured at a specified temperature with a power dissipation low enough that any further decrease in power will result only in a negligible change in resistance. Zero-power resistance may also be measured using a.c. if required by the detail specification.

4.3 *Temperature/resistance characteristic*

The relation at a specified direct voltage between the zero-power resistance of a PTC-S thermistor and the temperature of the thermosensitive element.

It is represented by a curve drawn on a semi-logarithmic co-ordinate graph (T (or θ) in linear abscissa and R in logarithmic ordinates).

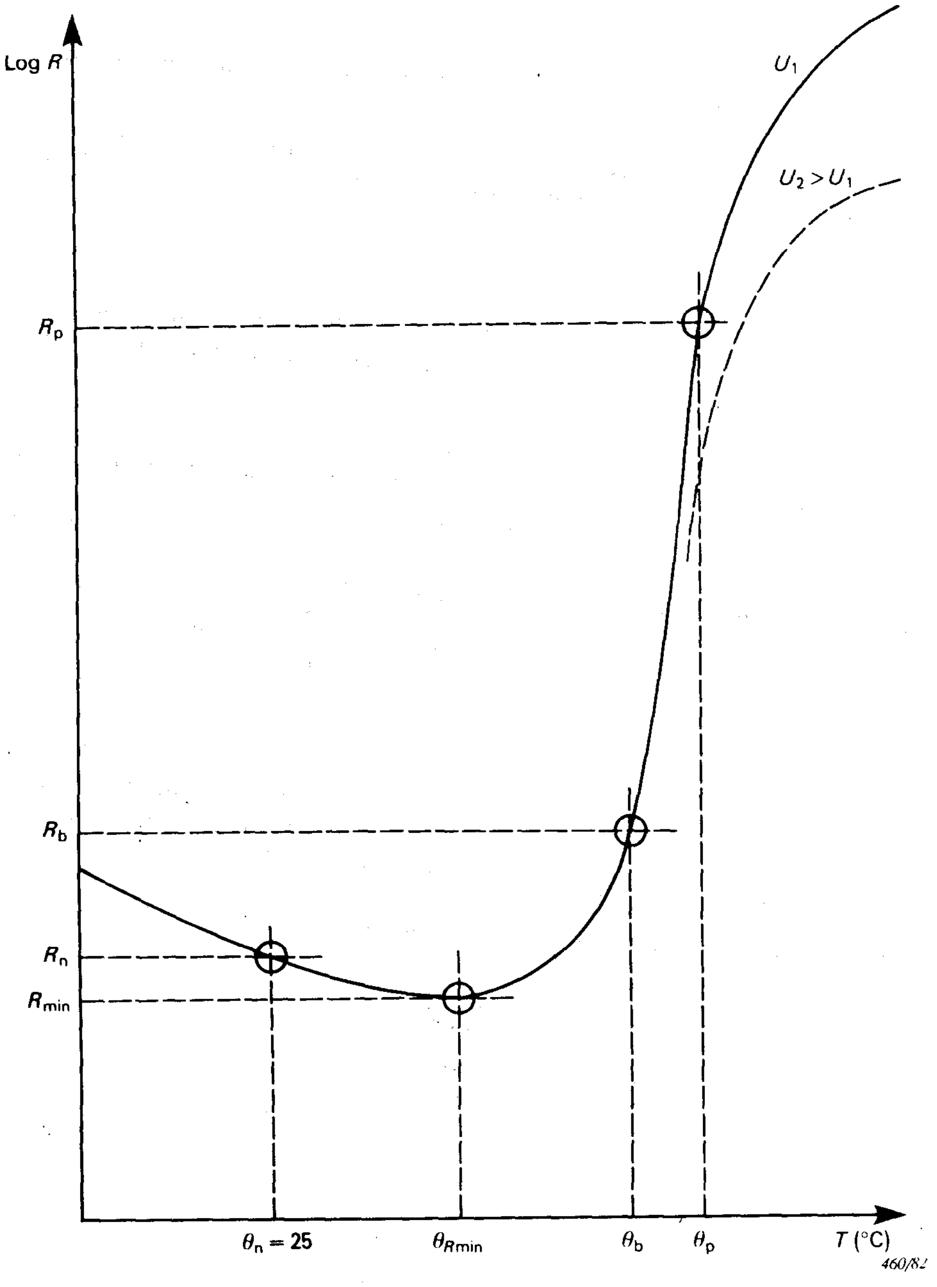


FIG. 1. — Typical resistance-temperature characteristic and definitions for PTC-S thermistors (at zero-power).

4.4 *Rated zero-power resistance* (R_n)

The zero-power resistance at 25 °C (298.15 K), unless another temperature is prescribed in the detail specification.

4.5 *Minimum resistance* (R_{min})

The zero-power resistance of the thermistor at temperature $T_{R_{min}}$ (or $\theta_{R_{min}}$) which is the lower limit of the PTC-S part of the resistance/temperature characteristic (see examples of curves in Sub-clause 4.3).

4.6 *Switching temperature* T_b (or θ_b)

The specified temperature at which the step-like increase of the resistance occurs (see Sub-clause 4.1).

4.7 *Switching resistance* (R_b)

The value of zero-power resistance corresponding to the switching temperature.

Note. — The switching resistance is expressed with reference to the minimum resistance (R_{min}) by a specified multiplying factor. It may also be expressed as an absolute value of resistance and independent of R_{min}.

4.8 *Temperature* T_p (or θ_p)

The chosen temperature in the PTC-S part of the resistance/temperature characteristic for which a minimum value R_p of the zero-power resistance is guaranteed.

4.9 *Resistance* R_p

The zero-power resistance at temperature T_p (or θ_p) measured at maximum voltage (see Sub-clause 4.13) and given as a minimum value.

4.10 *Temperature coefficient at zero-power of the resistance* (α_T)

Temperature coefficient is defined at a temperature T by the relation:

$$\alpha_T = \frac{1}{R_T} \cdot \frac{dR_T}{dT}$$

The temperature coefficient of the positive coefficient part of the resistance/temperature characteristic (log R – lin T) of thermistors is defined as being the angular coefficient of the secant passing through points T_b and T_p of the characteristic.

For the secant, the logarithm of the resistance R is directly proportional to the temperature T.

$$\log R = A \cdot T + B$$

$$\frac{dR}{dT} = \frac{AR}{\log e}$$

$$\alpha_T = \frac{A}{\log e}$$

$$\alpha_T = \frac{1}{\log e} \cdot \log \frac{R_p}{R_b} \cdot \frac{1}{T_p - T_b}$$

R_p and R_b must be measured at the same voltage, specified in the relevant detail specification.

Note. — The detail specification may specify the measurement of the temperature coefficient of resistance in a narrow temperature range where its value is a maximum. The detail specification shall also then provide a method.

4.11 *Maximum ambient temperature*

The maximum ambient temperature at which the thermistor may be put into steady-state operation. At this temperature, the resistor should no longer dissipate power.

4.12 *Maximum voltage* U_{max}

The maximum direct voltage which may be continuously applied to the thermistor after switching at 25 °C in still air (that is to say for stable operation in the PTC-S range of the temperature resistance characteristic).

Note. — Before switching, the current through the thermistor must be limited, if necessary, by a series resistor R_S.

4.13 *Dissipation factor* δ

The quotient of the change in power dissipation in a thermistor and the resultant temperature change of the element. This quotient is expressed in milliwatts per degree Celsius (see conditions of measurement in Sub-clause 9.3).

4.14 *Thermal time constant* τ

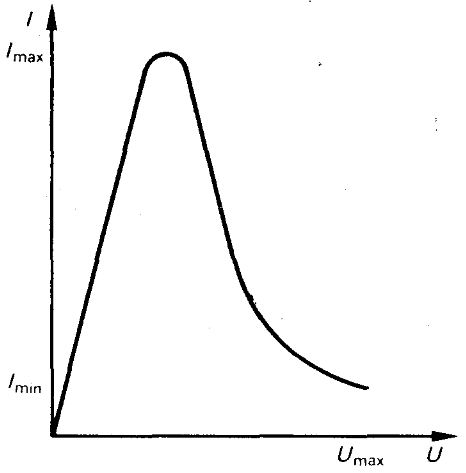
The time necessary for a thermistor to vary its temperature by 63.2% of the total difference between its initial temperature and its final temperature when it is subjected to a temperature step under zero-power conditions (see the conditions of measurement in Sub-clause 9.4).

4.15 *Calorific capacity of a thermistor* C_{th}

The quantity of heat to be supplied to the thermistor to raise its temperature by 1 °C. It is expressed in joules per degree Celsius.

4.16 *Voltage/current characteristic*

The relationship in still air at 25 °C (unless otherwise stated) between the applied voltage (d.c. or a.c.) at the thermistor terminations and the current under steady-state conditions, thermal equilibrium having been reached (see Figure 2 below).



461/82

FIGURE 2

Note. — PTC-S thermistors may have more than one voltage/current characteristic (at different ambient temperatures).

4.17 *Zero-power resistance ratio*

The zero-power resistance ratio characteristic identifies the ratio of the zero-power resistance of a thermistor measured at 25 °C to that resistance measured at the temperature θ_p as specified in the detail specification.

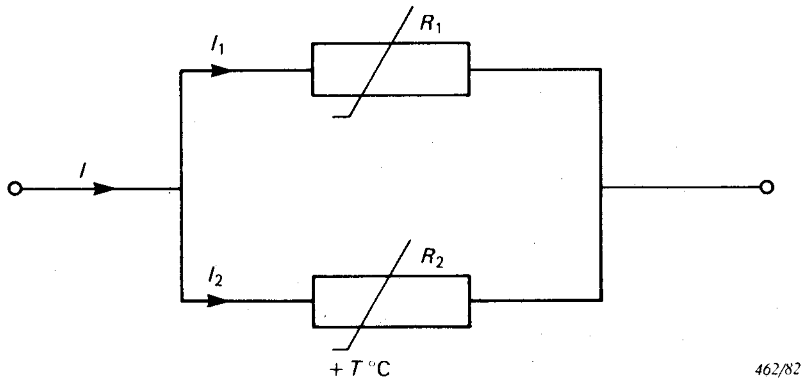
4.18 *Average zero-power resistance slope*

(Under consideration.)

4.19 *Voltage effect* (VDR effect)

At constant temperature and at zero-power, the resistance of a PTC-S thermistor depends on the voltage applied. This effect may be represented by means of the following equivalent circuit or by drawing the current/voltage characteristic at zero-power (pulse voltage).

The equivalent circuit of the thermistor has two parallel resistors, one R_2, having an ideal characteristic as a function of temperature, the other R_1, an ideal characteristic as a function of voltage and complying with the law $U = CI^{\beta}$.



$$U = C(I_1)^{\beta} = R_1 I_1$$
$$I = I_1 + I_2$$
$$U = I_2 R_2$$

FIGURE 3

The dependency between voltage and current is expressed by the value of β. It may be stated in the detail specification for a given temperature.

Equilibrium voltage (U_b) designates the voltage for which currents I_1 and I_2 are equal, when considering the equivalent circuit above.

4.20 *Frequency dependent effect (for information only)*

Reduction of the positive temperature coefficient of a PTC-S thermistor with the increase of the frequency of the applied voltage.

4.21 *Insulated thermistors (for information only)*

Thermistors capable of meeting the requirements of the insulation resistance and voltage proof tests as specified in the test schedule.

4.22 *Non-insulated thermistors*

Thermistors to which the isolation voltage and insulation resistance tests do not apply.

4.23 *Rated temperature range*

The ambient temperature range for which the thermistor has been designed for continuous operation; this range is limited on the one hand by the lower category temperature and on the other hand by the upper category temperature.

4.24 *Temperature range at maximum voltage*

The ambient temperature range over which the maximum voltage may be applied to the thermistor in continuous operation.

5. Identification

A thermistor complying with this standard is identified as follows:

- — by the type (see Sub-clause 5.1);
- — by the rated zero-power resistance and its tolerance (see Sub-clause 5.2);
- — by the classification (see Sub-clause 5.3);
- — by the maximum voltage;
- — by the zero-power resistance ratio (Sub-clause 4.17), if required by the detail specification.

5.1 *Type*

The type is characterized by:

- — design aspects (shape, coating, finish, outputs);
- — dimensions;
- — climatic category.

Characteristics particular to one type are stated in the detail specification which will also contain the other characteristics necessary for identification purposes.

A type is designated by the group of letters "PTC-S", which represent all those thermistors covered by this standard, followed by a characteristic number, given in the detail specification.

Associated types

These are types likely to be grouped together with a view to the same approval or same acceptance. These types shall have the same kind of terminations, the same form (insulated or not) and the same climatic category. Types which may be associated will be indicated in the detail specification.

Climatic category

The climatic category is coded in accordance with Appendix A of IEC Publication 68-1.

5.2 *Rated zero-power resistance and tolerance*

The rated resistances and tolerances on these values are given in the detail specification.

The rated resistances are preferably chosen from the values given in IEC Publication 63 and indicated in the detail specification.

5.3 *Classification*

PTC-S thermistors are classified according to the switching temperature.

The preferred classes are coded as shown in Table I.

The switching temperatures and corresponding classification are given in the detail specification.

TABLE I

Class	θ_b (°C)
D	−80
E	−60
F	−40
G	−20
H	0
J	+20
K	+40
L	+60
M	+80
N	+100
P	+120
R	+140
S	+160
T	+180
U	+200

6. Marking

6.1 *General*

6.1.1 The information given in the marking is normally selected from the following list; the relative importance of each item is indicated by its position in the list:

1) type designation
2) classification
3) rated zero-power resistance
4) tolerance
5) zero-power resistance ratio (if required by the detail specification)
6) manufacturer's name or trade mark
7) maximum voltage
8) switching temperature
9) year and month (or week) of manufacture
10) number of the detail specification.

6.1.2 The thermistor shall be clearly marked with 1), 2) and 6) above and with as many of the remaining items as is practicable. Any duplication of information in the marking on the thermistor should be avoided.

6.1.3 The package containing the thermistor(s) shall be clearly marked with all the information listed above.

6.1.4 Any additional marking shall be so applied that no confusion can arise.

6.2 *Coding*

When coding is used for resistance value, tolerance or date of manufacture, the method shall be selected from those given in IEC Publication 62.

SECTION TWO — QUALITY ASSESSMENT PROCEDURES

7. **Quality assessment procedures**

7.1 *Qualification Approval/Quality Assessment Systems*

7.1.1 For a full Quality Assessment System the procedures of Sub-clauses 7.4 and 7.6 shall be followed.

7.1.2 For Qualification Approval without Quality Conformance Inspection the procedures and requirements of Sub-clauses 7.4.1 and 7.4.2 *b)* shall apply.

7.2 *Primary Stage of Manufacture*

For the purpose of this specification, the primary stage of manufacture is the initial process of the mixing of the ingredients.

7.3 *Structurally Similar Components*

Thermistors may be grouped as structurally similar for the purpose of forming inspection lots provided that the following requirements are met:

They shall be produced by one manufacturer using essentially the same design, materials, processes and methods.

The sample taken shall be determined from the total sample size of the grouped components. For periodic tests the average value of such sample size shall be used.

Structurally similar components should preferably be included in one detail specification but the details of all claims to structural similarity shall be declared in the qualification approval test reports.

7.3.1 For electrical tests, devices having the same electrical characteristics may be grouped provided that the element determining the characteristics is similar for all the components concerned.

7.3.2 For environmental test, components having the same encapsulation, basic internal structure and finishing processes may be grouped.

7.3.3 For visual inspection (except marking), components may be grouped if they have been made on the same production line and have the same dimensions, encapsulation and external finish.

This grouping may also be used for robustness of terminations and soldering tests where it is convenient to group components with different internal structures.

7.3.4 For endurance test, thermistors may be grouped if they have been made on the same production line using the same design and differing only in electrical characteristics. If it can be shown that one style of the group is tested more severely than the others then tests on this style may be accepted for the remaining styles of the group.

7.4 *Qualification Approval Procedures*

7.4.1 The manufacturer shall comply with:

- — the general requirements of the rules of procedure governing qualification approval (IEC Publication QC 001002, Clause 11).
- — the requirements for the primary stage of manufacture contained in Sub-clause 7.2 of this document.

7.4.2 In addition to the requirements of Sub-clause 7.4.1, procedures *a)* or *b)* below shall apply:

a) The manufacturer shall produce test evidence of conformance to the specification requirements on three inspection lots for lot-by-lot inspection taken in as short a time as possible and one lot for periodic inspection. No major changes in the manufacturing process shall be made in the period during which the inspection lots are taken.

Samples shall be taken from the lots in accordance with IEC Publication 410 (see Appendix A). Normal inspection shall be used, but when the sample size would give acceptance on zero defectives, additional specimens shall be taken to meet the sample size required to give acceptance on one defective.

b) The manufacturer shall produce test evidence to show conformance to the specification requirements on the fixed sample size test schedule given in Sub-clause 7.5.

The specimens taken to form the sample shall be selected at random from current production or as agreed with the National Supervising Inspectorate.

7.4.3 Qualification Approval obtained as part of a Quality Assessment System, shall be maintained by regular demonstration of compliance with the requirements for Quality Conformance (see Sub-clause 7.6).

7.5 *Qualification Approval on the basis of the fixed sample size procedure*

7.5.1 *Sampling*

The sample shall be representative of the range of values for which approval is sought. This may or may not be the complete range covered by the detail specification.

The sample shall consist of specimens having:

a) the highest and the lowest resistance values for which approval is being sought, when there are several rated resistance values and only one switching temperature in the range being submitted.

b) the highest and the lowest switching temperature values for which approval is being sought, when there are several switching temperature values and only one rated resistance value in the range being submitted.

c) the highest resistance value together with the highest switching temperature value and the lowest resistance value together with the lowest switching temperature value for which approval is being sought, when there are several rated resistance values and several switching temperature values in the range being submitted.

d) the resistance value and the switching temperature value, if approval is being sought for only one rated resistance value and only one switching temperature value.

The proportion of specimens having the different characteristics shall be proposed by the manufacturer's Chief Inspector and shall be to the satisfaction of the National Supervising Inspectorate.

Spare specimens are permitted as follows:

a) one per resistance value and one per switching temperature value which may be used to replace the permitted defective in Group "0".

b) one per resistance value and one per switching temperature value which may be used to replace specimens which are defective because of incidents not attributable to the manufacturer.

When additional groups are introduced into the Qualification Approval test schedule, the number of specimens required for Sub-group "0a" shall be increased by the same number as that required for the additional groups.

7.5.2 *Tests*

The complete series of the tests specified in Table II are required for the approval of thermistors covered by one detail specification. The tests of each group shall be carried out in the order given.

The whole sample shall be subjected to the tests of Sub-group "0a" and then divided for the other groups.

Specimens found defective during the tests of Group "0" shall not be used for the other groups.

"One defective" is counted when a thermistor has not satisfied the whole or a part of the tests of a group.

Approval is granted when the number of defectives does not exceed the number or permissible defectives specified.

TABLE II

Test schedule for Qualification Approval

Notes 1. — In this table:
n = sample size
c = group acceptance criterion (permitted number of defectives per group or sub-group)
t = total acceptance criterion (permitted number of defectives for one or several groups combined)
D = destructive; ND = non-destructive.

2. — Insulated thermistors only.

3. — If required in the detail specification.

4. — Specimens from Sub-group 0b.

5. — These specimens are drawn from:
— for one half, specimens that have passed the tests of Sub-group 1a;
— for the other half, specimens that have passed the tests of Sub-group 1b.

Clause and sub-clause number and Test	D or ND	Conditions of test	Sample size and criterion of acceptability (see Note 1)			Performance requirements
			n	c	t	
Group 0	ND		46	1	3	
Sub-group 0a			46			
8.3.2 Visual examination						No visible damage
8.3.1 Dimensions						As specified in the detail specification
6. Marking						Legible marking
9.1 Zero-power resistance R_n		Measuring voltage: d.c. (a.c. if required by the detail specification) Total measuring error, if larger than 10%: ...%				Within specified tolerance
Spare specimens		See 7.5.1				
Sub-group 0b			26			
9.6 Voltage proof 2)		Mounting method: ... Voltage, if other than 700 V peak: ... V				No breakdown, flashover or discharge
9.7 Insulation resistance 2)		Mounting method: ... Voltage, if other than 100 ± 15 V: ... V				$R_i \geqslant \ldots$ MΩ
Sub-group 0c			6			
9.3 Dissipation factor		Clamping method: ... Distance clamping point to body: ... mm				$\delta \ldots$ mW/°C
9.4 Thermal time constant		Clamping method: ... Distance clamping point to body: ... mm				$\tau \ldots$ s
Group 1	D			1		
Sub-group 1a			10 4)			
10.1 Robustness of terminations		Tensile, bending and torsion tests as appropriate to the type of termination				
		Visual examination				No visible damage
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant \ldots\%$

Sub-clause number and Test	D or ND	Conditions of test	Sample size and criterion of acceptability (see Note 1)			Performance requirements
			n	c	t	
10.2.2 Resistance to soldering heat		(The detail specification shall indicate whether Method 1A or 1B of Test Tb of IEC Publication 68-2-20A applies)				
		Visual examination				No visible damage
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant \ldots\%$
Sub-group 1b			6[4]			
10.2.1 Solderability		Method, if other than Method 1): ...				Good tinning as evidenced by free flowing of the solder with wetting of the terminations
		(The detail specification shall indicate the procedure for thermistors intended to be used only on printed boards)				
10.4 Vibration		Mounting method: see 10.4				
		Frequency range, if other than 10 Hz to 55 Hz: ... Hz				
		Amplitude 0.75 mm or acceleration 98 m/s^2 (whichever is the less severe)				
		Duration: 6 h				
		Visual examination				No visible damage
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant \ldots\%$
10.5 Bump[3]		Mounting method: see 10.4				
		Acceleration: ... m/s^2				
		Number of bumps: ...				
		Visual examination				No visible damage
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant \ldots\%$
Sub-group 1c			6[5]			
10.3 Rapid change of temperature		Temperatures: see 10.3				
		Number of cycles: ...				
		Duration: ...				
		Visual examination				No visible damage Legible marking
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant \ldots\%$
10.6 Climatic sequence — Dry heat — Damp heat, cyclic test, Test D_b, first cycle — Cold						
— Low air pressure[3]		Mounting method: ...				No breakdown, flashover or discharge
		Air pressure: 2 kPa (20 mbar)				
		Voltage: ... V				

Sub-clause number and Test	D or ND	Conditions of test	Sample size and criterion of acceptability (see Note 1)			Performance requirements
			n	c	t	
— Damp heat, cyclic test, Test D_b, remaining cycles						
— Final measurements		Visual examination				No visible damage Legible marking
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant \ldots\%$
		Voltage proof[2]				No breakdown, flashover or discharge
		Insulation resistance[2]				$R \geqslant \ldots$ MΩ
Group 2 10.7 Damp heat, steady state	D	Visual examination	10[4]	1		No visible damage Legible marking
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant \ldots\%$
		Voltage proof[2]				No breakdown, flashover or discharge
		Insulation resistance[2]				$R \geqslant \ldots$ MΩ
Group 3 9.2 Temperature coefficient at zero-power dissipation	D	Measuring voltage: ... V Temperature range, if other than T_p to T_b: ... Method: ...	10	1		α_T: ... ± ...
10.8.1 Endurance at maximum voltage		Temperature range: ... °C to ... °C Clamping method: ... Duration: 1 000 h Test A: all specimens (half the number of specimens if Test B is also made): Series resistance: ... Ω Test B: (if required in the detail specification) the other half of the specimens: Temperature: ... °C t_1: ... min t_2: ... min Number of cycles: ... Series resistance: ... Ω Examination at 48 h and 500 h:				
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant \ldots\%$
		Examination at 1 000 h Visual examination				No visible damage Legible marking
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant \ldots\%$

Sub-clause number and Test	D or ND	Conditions of test	Sample size and criterion of acceptability (see Note 1)			Performance requirements
			n	c	t	
Group 4 11.8.2 Endurance at maximum ambient temperature at zero-power dissipation	D	Duration: 1 000 h Examination at 48 h and 500 h:	10	1		
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant ...\%$
		Examination at 1 000 h: Visual examination				No visible damage Legible marking
		Zero-power resistance				$\frac{\Delta R_T}{R_T} \leqslant ...\%$

7.6 *Quality Conformance Inspection*

The blank detail specification(s) associated with the generic specification shall prescribe the test schedule for Quality Conformance Inspection.

This schedule shall also specify the grouping, sampling and periodicity for the lot-by-lot and periodic inspection.

Inspection Levels and AQL's shall be selected from those given in IEC Publication 410.

If required, more than one schedule may be specified.

7.6.1 *Formation of inspection lots*

An inspection lot shall consist of thermistors of the same style or associated styles. It should be representative of those extremes of the resistance range and switching temperature range produced during the inspection period.

Styles having the same nominal dimensions but different temperature characteristics of resistance produced during the period may be aggregated, except for the purpose of sub-groups which contain a test for temperature coefficients of resistance. The low and high values of the ranges of resistance and switching temperature for which Qualification Approval has been granted shall be inspected during a period which is approved by the National Supervising Inspectorate.

The samples for Group "C" shall be collected over the last 13 weeks of the inspection period.

7.6.2 *Test schedule*

The schedule for the lot-by-lot and periodic tests for Quality Conformance Inspection is given in Section Two, Table III of the Blank Detail Specification, IEC Publication 738-1-1.

7.6.3 *Assessment levels*

The assessment level(s) given in the blank detail specification shall preferably be selected from the following Tables IV A and IV B:

TABLE IV A

Inspection sub-groups**	D*		E		F*		G*	
	IL	AQL %	IL	AQL %	IL	AQL %	IL	AQL %
A1			II	4.0				
A2			II	1.0				
A3			II	1.0				
B			S-3	4.0				

IL = inspection level
AQL = acceptable quality level

TABLE IV B

Inspection sub-groups**	D*			E			F*			G*		
	p	n	c	p	n	c	p	n	c	p	n	c
C1A				6	10	1 } 3						
C1B				6	6							
C1C				6	6							
C2				6	10	1						
C3				6	10	1						
C4				6	10	1						

p = periodicity in months
n = sample size
c = permitted number of defectives

Notes concerning Tables IV A and IV B:

* The assessment levels D, F and G are under consideration.

** The content of the Inspection sub-groups is described in Section Two of the relevant Blank Detail Specification.

7.6.4 *Certified Records of Released Lots*

When certified records of released lots are prescribed in the relevant specification and are requested by a purchaser, the following information shall be given as a minimum:

- — attributes information (i.e. number of components tested and numbers of defective components) for tests in the sub-groups covered by periodic inspection without reference to the parameter(s) for which rejection was made;
- — variables information for the change in zero-power resistance after the 1 000 h endurance test.

7.6.5 *Delayed delivery*

Thermistors held for a period exceeding two years following the release of the lot shall, before delivery, be re-examined for solderability and zero-power resistance as specified in Group A or B Inspection of the detail specification.

The re-examination procedure adopted by the manufacturer's Chief Inspector shall be approved by the National Supervising Inspectorate.

Once a "lot" has been satisfactorily re-inspected, its quality is re-assured for the specified period.

7.6.6 *Release for delivery before the completion of Group B tests*

When the conditions of IEC Publication 410 for changing to reduced inspection have been satisfied for the Group B tests, the manufacturer is permitted to release components before the completion of such tests.

7.6.7 *Alternative test methods*

The test and measurement methods given in the relevant specification are not necessarily the only methods which can be used. However, the manufacturer shall satisfy the National Supervising Inspectorate that any alternative methods which he may use will give results equivalent to those obtained by the methods specified. In case of dispute, for referee and reference purposes, the specified methods only shall be used.

SECTION THREE — TEST AND MEASUREMENT PROCEDURES

8. **Test and measurement procedures**

8.1 *General*

The blank detail specification shall contain tables showing the tests to be made, which measurements are to be made before and after each test or sub-group of tests, and the sequence in which they shall be made. The stages of each test shall be carried out in the order written. The measuring conditions shall be the same for initial and final measurements.

If national specifications within any Quality Assessment System include methods other than those specified in the above documents, they shall be fully described.

8.2 *Standard atmospheric conditions for testing*

Unless otherwise specified, all the tests are carried out under the standard atmospheric conditions for testing specified in IEC Publication 68-1.

In case of dispute, the referee conditions shall be 25 ± 1 °C, 48% to 52% r.h. and 860 to 1 060 mbar pressure. Before the initial measurements of each group or sub-group, the specimens shall be stored under the standard conditions for testing for 24 hours. Before the intermediate or final measurements, the thermistors shall be placed in the recovery conditions*, stated in IEC Publication 68-1, for 4 ± 1 h.

The mounting devices shall not affect the results of measurements.

---

* Standard recovery conditions of IEC Publication 68-1:

Temperature: actual laboratory temperature ± 1 °C, subject to the overriding requirements of Sub-clause 5.3 i.e. within + 15 °C to + 35 °C.

Relative humidity: 45%-75%.

Air pressure: 860 mbar to 1 060 mbar.

8.3 *Visual examination*

8.3.1 *Outline drawing and dimensions*

There shall be an illustration of the thermistor as an aid to easy recognition and for comparison of the thermistor with others.

Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall preferably be stated in millimetres, however when the original dimensions are given in inches, the converted metric dimensions in millimetres shall be added.

Normally the numerical values shall be given for the length of the body, the width and height of the body and the wire spacing or, for cylindrical types, the body diameter, and the length and diameter of the terminations.

When necessary, for example when in a detail specification more than one case size is covered, the dimensions and their associated tolerances shall be placed in a table below the drawing.

When the configuration is other than cylindrical with axial terminations, the detail specification shall state such dimensional information as will adequately describe the thermistor.

When the thermistor is not designed for use on printed boards, this shall be clearly indicated in the detail specification.

The dimensions shall comply with those given in the detail specification and shall be measured in accordance with IEC Publication 294 if cylindrical types with axial terminations are concerned.

8.3.2 *Visible damage*

Visible damage is defined as any visible damage which would reduce the usability of the product for its intended purpose.

9. **Electrical tests**

9.1 *Zero-power resistance*

Procedure

The thermistors shall be fixed in corrosion resistant clamps by their usual means*.

The thermistors are then immersed in an insulating medium not likely to cause deterioration, the temperature of which is maintained at the specified value.

The zero-power resistance is measured when it has stabilized.

The measuring method used shall be such that the total measuring error is less than 10% of the zero-power resistance tolerance, unless otherwise stated in the detail specification.

---

* A preferred means of mounting is given in Appendix C for measurements in air and when self-heating may occur. This method shall be used in the event of dispute.

The total measuring error is the sum of the errors due to:

- temperature variation of the measuring medium;
- temperature rise of the thermistor due to the measuring current (Joule effect);
- resistance measuring instrument.

Requirement

The zero-power resistance shall be within the specified tolerance.

9.2 *Temperature coefficient at zero-power dissipation α_T*

Procedure

The values R_p and R_b are measured at the same voltage specified in the relevant detail specification.

The temperature coefficient at zero-power α_T is calculated by means of the formula given in Sub-clause 4.10.

Requirement

The temperature coefficient thus calculated shall be within the limits stated in the detail specification.

9.3 *Dissipation factor δ*

Procedure

Mounting

The thermistors are held in accordance with one of the clamping methods shown in Appendix C, unless otherwise specified.

The distance (in millimetres) of the clamping point in relation to the body is stated in the detail specification. It is the highest value in the series 1 – 2.5 – 5 and decimal multiples compatible with the length of terminations.

When the terminations are insulated, measurements are carried out at their end-points, irrespective of their lengths.

Initial measurement

Zero-power resistance at 25 °C in accordance with Sub-clause 9.1.

Test

The thermistors are introduced in still air at 25 ± 0.5 °C in a test chamber, the volume of which is at least 1 000 times that of the thermistors under test, in such a way that no thermistor is less than 75 mm from other thermistors or from the wall of the enclosure.

1) The voltage U_{max} is applied and the corresponding current I is measured. By calculation, the ratio $\frac{U_{max}}{I}$ and the corresponding power are deduced.
2) The resultant temperature increase is calculated: $\Delta\theta = \frac{P}{\delta}$ (δ being the value stated in the detail specification).

3) Two measuring temperatures are calculated: $\theta_1 = 25 + \Delta\theta - 5$
$\theta_2 = 25 + \Delta\theta + 5$

4) At temperatures θ_1 and θ_2, the values R_1 and R_2 of the zero-power resistance are measured for an applied voltage pulse having a peak value equal to $U_{\max}$.

5) By interpolation, the temperature θ_3, at which the zero-power resistance is equal to $\frac{U_{\max}}{I}$, is evaluated.

6) $\delta = \dfrac{P}{\theta_3 - 25}$.

Requirement

The dissipation factor δ thus calculated shall correspond to the value stated in the detail specification, taking into account the tolerance.

9.4 *Thermal time constant τ*

Procedure

Mounting

The thermistors are held in position in accordance with one of the clamping methods shown in Appendix C, unless otherwise specified.

The distance (in millimetres) of the clamping point in relation to the body is stated in the detail specification. It is the highest value in the series 1 – 2.5 – 5 and decimal multiples compatible with the length of terminations.

When the terminations are insulated, measurements are carried out at their end-points, irrespective of their lengths.

Test

The thermistors are introduced in still air at temperature θ_0 ($\theta_0 = 25 \pm 0.5$ °C) in the test chamber described in Sub-clause 9.3.

Before introduction in the test chamber, the thermistors are inserted in the circuit shown in the figure below:

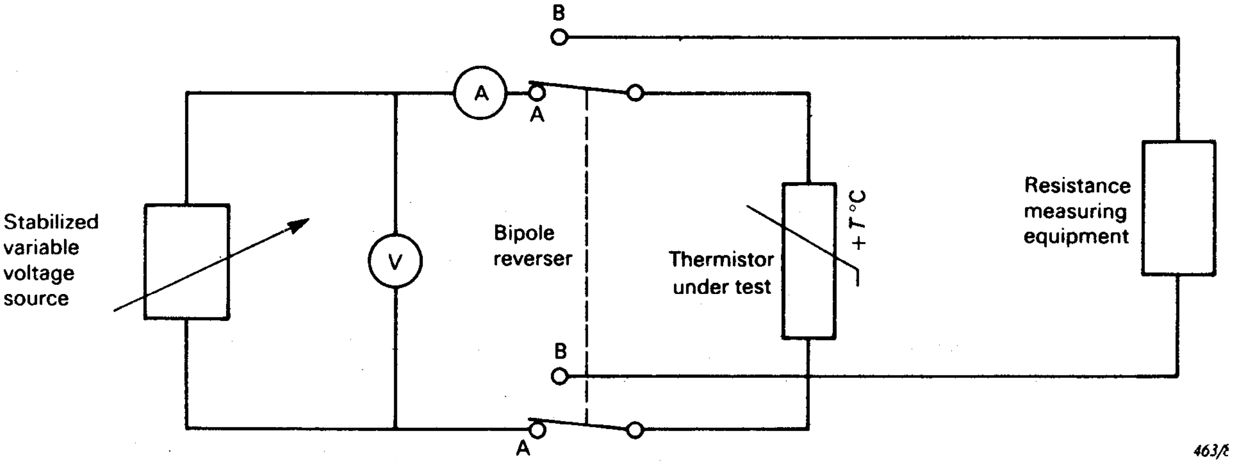


FIGURE 4

The high impedance voltmeter and the ammeter shall measure to an accuracy of 1%. The resistance measuring equipment shall measure to an accuracy of 0.1% or less.

Depending on the cases determined below, method *a* or *b* shall be used:

Method a

Applicable when: $\theta_3 - \theta_b > 63.2\% \, (\theta_3 - \theta_0)$

Initial measurements: $R_{\theta 3}$ and $R_{\theta 1}$ with $\theta_1 = \theta_3 - 0.632 \, (\theta_3 - \theta_0)$

With the contacts AA made, the voltage is so adjusted that the power dissipated in the thermistor raises its temperature to a value slightly above θ_3 (calculated as in Sub-clause 9.3) and the indications of the instruments are stable.

The applied power may then, for example, be calculated as follows:

$$P = U \cdot I = 1.1 \, (\theta_3 - \theta_0) \cdot \delta$$

where δ is the value calculated according to Sub-clause 9.3.

Contacts BB are then made by means of the reverser and measurement of the time is started as soon as the resistance value has returned to $R_{\theta 3}$ and the resistance measuring equipment is in balance.

Time measurement is stopped when the resistance measuring equipment indicates a value of $R_{\theta 1}$.

The elapsed time t is noted. In this case, it represents the thermal time constant.

Method b

Applicable when: $\theta_3 - \theta_b \leqslant 63.2\% \, (\theta_3 - \theta_0)$

Initial measurements: $R_{\theta 3}$ and R_b

With the contacts AA made, the voltage is so adjusted that the power dissipated in the thermistor raises its temperature to a value slightly above θ_3 and the indications of the instruments are stable.

The applied power may then, for example, be calculated as follows:

$$P = U \cdot I = 1.1 \, (\theta_3 - \theta_0) \cdot \delta$$

where δ is the value calculated according to Sub-clause 9.3.

Contacts BB are then made by means of the reverser and measurement of the time is started as soon as the resistance value has returned to $R_{\theta 3}$ and the resistance measuring equipment is in balance.

Time measurement is stopped when the resistance measuring equipment indicates a value of R_b. The elapsed time t is noted, and the thermal time constant is then calculated as follows:

$$\tau = \frac{t}{\log_e \dfrac{\theta_3 - \theta_0}{\theta_b - \theta_0}}$$

Notes 1. — For thermistors with low time constants, automatic switching should be provided between both resistance measurements, as well as for measuring the time interval between both equilibria.

2. — The power applied to the thermistor via the resistance measuring equipment shall be sufficiently low to enable the zero-power resistance of the thermistor to be measured.

Requirement

The thermal time constant shall correspond to the value given in the detail specification, taking into account the tolerance.

9.5 *Calorific capacity*

Note. — This sub-clause does not describe a particular test, but enables information to be obtained which might be of interest to some users.

9.5.1 *Calorific capacity C_{th} of a thermistor*

The calorific capacity C_{th} of a thermistor is deduced from the previous measurements by means of the formula:

$$C_{th} = \tau \times \delta$$

τ being the time constant
δ being the dissipation factor.

9.5.2 *Calorific capacity of the ceramic alone (for information)*

The calorific capacitance of the ceramic alone is calculated in the same way.

The dissipation factor and thermal time constant are measured as previously, but the power shall be applied to the ceramic by means of connections of negligible thermal capacitance and high thermal resistance (e.g. platinum wires of 60 µm diameter).

9.6 *Voltage proof* (for insulated thermistors only)

According to the instructions given in the relevant detail specification, one of the following test methods is used:

Method 1

The non-insulated parts of the thermistor shall be wrapped in insulating material of very high insulation value.

The whole is inserted into a box containing lead balls of 1.6 ± 0.2 mm diameter, in such a manner that only the connections of the thermistor emerge. An electrode is inserted into the lead balls.

Method 2

A metal foil shall be wrapped closely around the body of the thermistor. For those types not having axial leads, a space of 1 mm to 1.5 mm shall be left between the edge of the foil and each termination. For those types having axial leads, the foil shall be wrapped around the whole body of the thermistor protruding by at least 5 mm from each end, provided that the minimum space of 1 mm between the foil and each termination can be maintained. The ends of the foil shall not be folded over the ends of the thermistor.

Method 3

The thermistor shall be clamped in the trough of a 90° metallic V-block of such size that the thermistor body does not extend beyond the extremities of the block.

The clamping force shall be such as to maintain adequate contact between the thermistor and the block.

The terminations shall be so positioned that the distance between the terminations and any point of the V-block is not less than:

a) For cylindrical thermistors: the thermistor shall be positioned in the block so that the termination furthest from the axis of the thermistor is nearest to one of the faces of the block.

b) For rectangular thermistors: the thermistor shall be positioned in the block so that the termination nearest to the edge of the thermistor is nearest to one of the faces of the block.

For cylindrical and rectangular thermistors with axial leads, any out-of-centre positioning of the point of emergence of the terminations from the thermistor body shall be ignored.

Test

An alternating voltage of a frequency of 40 Hz to 60 Hz, with a peak value of 700 V, unless otherwise stated in the detail specification, is applied for 1 min ± 5 s between the terminations of the thermistor connected to each other to form one pole, and, depending on the method of mounting used, with the electrode inserted in the lead balls, or the metal sheet, forming the other pole.

The voltage shall be applied progressively with a maximum step of 100 V per second.

Requirement

No puncture, flashover or discharge shall occur.

9.7 *Insulation resistance (for insulated thermistors only)*

Procedure

Depending on the instructions in the detail specification, one of the methods of mounting given in Sub-clause 9.6 is used.

The insulation resistance is measured under a d.c. voltage of 100 ± 15 V, unless otherwise stated in the detail specification, between the terminations of the thermistors interconnected to form one pole, and, depending on the method of mounting used, the electrode inserted in the metal ball bearings or the metal sheet forming the other pole.

The voltage shall be applied for one minute, or for a shorter period but sufficient to obtain a stable reading. The insulation resistance is noted at the end of each period.

Requirement

Minimum insulation resistance: see detail specification.

10. **Environmental tests**

10.1 *Robustness of terminations*

Procedure

The test is carried out in accordance with Test U of IEC Publication 68-2-21 (1975), with the following particular requirements:

10.1.1 *Initial measurement*

Zero-power resistance at 25 °C (in accordance with Sub-clause 9.1).

10.1.2 *Test*

Test Ua: Tensile.

The loading weight to be applied for 10 s shall be:

For all types of terminations, except wire terminations: 20 N.

For wire terminations, see the table below:

Nominal cross-sectional area (mm^2)	Corresponding diameter for circular-section wires (mm)	Force (N)
$S \leqslant 0.05$	$d \leqslant 0.25$	1
$0.05 < S \leqslant 0.07$	$0.25 < d \leqslant 0.3$	2.5
$0.07 < S \leqslant 0.2$	$0.3 < d \leqslant 0.5$	5
$0.2 < S \leqslant 0.5$	$0.5 < d \leqslant 0.8$	10
$0.5 < S \leqslant 1.2$	$0.8 < d \leqslant 1.25$	20
$1.2 < S$	$1.25 < d$	40

Test Ub: Bending (half the number of terminations).

Two consecutive bends shall be applied (Method 1).

Test Uc: Torsion (other half of the terminations).

Two rotations of 180° shall be applied (Severity 2).

10.1.3 *Visual examination*

After each of these tests, the thermistors shall be visually examined. There shall be no visible damage.

10.1.4 *Final measurements and requirements*

After the test, the zero-power resistance shall be measured according to Sub-clause 9.1. The change of resistance compared with the value measured in Sub-clause 10.1.1 shall not exceed the limit specified in the detail specification.

10.2 *Soldering*

10.2.1 *Solderability*

Procedure

The test is carried out in accordance with Test T of IEC Publication 68-2-20 (1968) with the following particular requirements:

10.2.1.1 *Test*

- Bath method (unless otherwise stated in the detail specification).
- Procedure: the terminations are immersed in turn up to 6 mm from the body of the component.

Note. — For thermistors intended to be used only on printed boards the test procedure is laid down in the detail specification.

10.2.1.2 *Requirement*

The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations.

10.2.2 *Resistance to soldering heat*

Procedure

The test is carried out in accordance with Test Tb of IEC Publication 68-2-20A (1970) with the following particular requirements:

10.2.2.1 *Initial measurement*

Zero-power resistance at 25 °C (in accordance with Sub-clause 9.1).

10.2.2.2 *Test*

— Bath method 1A (unless otherwise stated in the detail specification).
— Procedure: the terminations are immersed in turn up to 6 mm from the body of the thermistor.

Note. — For thermistors intended to be used only on printed boards the test procedure is laid down in the detail specification.

10.2.2.3 *Final inspection and measurements*

— Appearance.
— Zero-power resistance at 25 °C (in accordance with Sub-clause 9.1).

10.2.2.4 *Requirements*

— No mechanical deterioration.
— Maximum change of resistance: see detail specification.

10.3 *Rapid change of temperature*

Procedure

The test is carried out in accordance with Test Na of IEC Publication 68-2-14 with the following particular requirements:

10.3.1 *Initial measurement*

Zero-power resistance at 25 °C (in accordance with Sub-clause 9.1).

Required temperatures

Minimum temperature of the climatic category limited to −55 °C and the maximum temperature of the climatic category. The number of cycles and duration of exposure to be prescribed in the relevant detail specification.

10.3.2 *Final inspection and measurements*

— Appearance.
— Marking.
— Zero-power resistance at 25 °C.

10.3.3 *Requirements*

- — No mechanical deterioration.
- — Marking shall remain legible.
- — Maximum change of resistance: see detail specification.

10.4 *Vibration*

Procedure

The test is carried out in accordance with Test Fc (Procedure B4) of IEC Publication 68-2-6 with the following particular requirements:

10.4.1 *Initial measurement*

Zero-power resistance at 25 °C (in accordance with Sub-clause 9.1).

Mounting

For thermistors usually held by their connection wires:

a) thermistors with axial terminations: the connection wires held in the position stated in the detail specification are fixed to a rigid support 6 ± 1 mm from the body of the thermistor;

b) thermistors with radial terminations: at the clamping point given in the detail specification.

For other thermistors: fixed in accordance with the usual method of attachment or, if this does not exist, in accordance with the requirements given in the detail specification on a rigid support integral with the vibration apparatus.

10.4.2 *Test*

- — Frequency range: 10 Hz to 55 Hz (unless otherwise prescribed in the detail specification),
- — Amplitude: 0.75 mm or acceleration 98 m/s^2,
- — Duration: 6 h;
- — Direction of vibration application: one direction parallel to the terminations, two directions perpendicular to the first, one of which is parallel to the likely plane of the terminations.

10.4.3 *Final inspection and measurements*

- — Appearance.
- — Zero-power resistance at 25 °C (in accordance with Sub-clause 9.1) before dismantling from the support where components have been soldered in order to undergo the tests.

10.4.4 *Requirements*

- — No mechanical deterioration.
- — Maximum change of resistance: see detail specification.

10.5 *Bump*

(Under consideration.)

10.6 *Climatic sequence*

Procedure

The test is carried out in accordance with IEC Publication 68 with the following particular requirements:

10.6.1 *Initial measurement*

Zero-power resistance at 25 °C.

10.6.2 *Test*

Dry heat

The thermistors are subjected to test method Ba of IEC Publication 68-2-2 with the degree of severity appropriate to the climatic category for 16 h.

They are then placed under standard recovery conditions until the end of the 24 h period.

10.6.3 *Damp heat, cyclic, Test Db, first cycle*

The thermistors are subjected to Test Db of IEC Publication 68-2-30, severity b (55 °C).

10.6.4 *Cold*

The thermistors are subjected to Test Aa of IEC Publication 68-2-1 with the degree of severity appropriate to the climatic category for 16 h. They are then placed under standard recovery conditions until the end of the 24 h period.

10.6.5 *Low air pressure*

The detail specification shall state whether this test is applicable.

10.6.5.1 *Procedure*

The test is carried out in accordance with Test M of IEC Publication 68 with the following particular requirements:

Initial measurement

None.

Mounting

The method of mounting used (*a* or *b*) (see Sub-clause 9.6) is stated in the detail specification.

10.6.5.2 *Test*

- — Required pressure: 20 mbar.
- — Operation: application of a voltage proof test, in accordance with Sub-clause 9.6, but at the voltage given in the detail specification.
- — Duration of low pressure: the time needed to carry out the voltage proof test.

10.6.5.3 *Final measurement*

None.

10.6.5.4 *Requirement*

No breakdown, flashover or discharge shall occur.

10.6.6 *Damp heat, cycle, Test Db, remaining cycles* *

The thermistors are subjected to Test Db of IEC Publication 68-2-30 for the following number of cycles:

Categories	Number of cycles
–/–/56	5
–/–/21	1
–/–/10	None
–/–/04	None

10.6.6.1 *Final inspection and measurements*

- — Appearance.
- — Marking.
- — Zero-power resistance (in accordance with Sub-clause 9.1).
- — Voltage proof (in accordance with Sub-clause 9.6) } for insulated
- — Insulation resistance (in accordance with Sub-clause 9.7) } thermistors only.

10.6.6.2 *Requirements*

- — No mechanical deterioration.
- — Marking shall remain legible.
- — Maximum change of resistance: in accordance with the limit stated in the detail specification.
- — No breakdown, flashover or discharge shall occur.
- — Minimum insulation resistance: see detail specification.

10.7 *Damp heat, steady state*

Procedure

The test is carried out in accordance with Test Ca of IEC Publication 68-2-3 with the following particular requirements:

Initial measurements

Zero-power resistance at 25 °C (in accordance with Sub-clause 9.1).

10.7.2 *Test*

- — Severity: dependent on the climatic category.
- — Operation (for insulated thermistors only): a direct voltage is applied to the thermistors throughout the test. The voltage value is taken from the R5 series range of values. It is limited to the value immediately less than ½0th of the maximum voltage.

---

* Alternatively the accelerated damp heat Test D may still be used for the next five years, however Test Db is preferred.

10.7.3 *Final inspection and measurements*

— Appearance.
— Marking.
— Zero-power resistance at 25 °C (in accordance with Sub-clause 9.1).
— Voltage proof (in accordance with Sub-clause 9.6) } for insulated thermistors only.
— Insulation resistance (in accordance with Sub-clause 9.7) } for insulated thermistors only.

10.7.4 *Requirements*

— No mechanical deterioration.
— Marking shall remain legible.
— Maximum change of resistance: see detail specification.
— No puncture, flashover or discharge shall occur.
— Minimum insulation resistance: see detail specification.

10.8 *Endurance*

10.8.1 *Endurance at maximum voltage*

Procedure

Mounting

The thermistors are held in position in accordance with one of the methods of clamping given in Appendix C, unless otherwise specified.

10.8.1.1 *Initial measurement*

There shall be two options:

Option 1: All specimens are subjected to Test A.
Option 2: If required by the detail specification, one half of the specimens shall be subjected to Test A and the other half to Test B.

Test A

The thermistors are placed in the test chamber described in Sub-clause 9.3, maintained at a temperature of 25 °C.

Throughout the test, the thermistors are subjected to successive cycles consisting of a 90 min application of the permissible maximum voltage at 25 °C, followed by a 30 min rest period. The value of the resistor to be placed in series with the thermistor (R_s) is given in the detail specification. The test duration is 1 000 ± 24 h.

Test B

The thermistors are placed in the test chamber described in Sub-clause 9.3, maintained at the temperature given in the detail specification.

Throughout the test, the thermistors are subjected to cycles comprising of a period t_1 with application of the maximum voltage and a rest period t_2.

The values of t_1 and t_2, the number of cycles; and the values of the resistor to be placed in series with the thermistor (R_s) are given in the detail specification.

The test duration is 1 000 ± 24 h.

Measurement during test: Zero-power resistance at 25 °C.

This measurement is carried out at the following stages of the test, after a recovery time of 1 to 2 h: 168 h, 500 h and 1 000 h.

10.8.1.2 *Final inspection and measurements*

- Appearance.
- Marking.
- Zero-power resistance at 25 °C.

10.8.1.3 *Requirements*

- No mechanical deterioration.
- Marking shall remain legible.
- Change of resistance between the initial measurement and each of the measurements during test: in accordance with the detail specification.

10.8.2 *Endurance at maximum ambient temperature at zero-power dissipation*

Procedure

10.8.2.1 *Initial measurement*

Zero-power resistance at 25 °C.

Test

The thermistors are placed in a moving-air test chamber, raised to the maximum ambient temperature (±2 °C) and maintained at that temperature for 1 000 h at zero-power.

Measurement during test: Zero-power resistance.

This measurement is carried out at the following stages of the test, after a recovery time of 1 to 2 h: 168 h, 500 h and 1 000 h.

10.8.2.2 *Final inspection and measurements*

- Appearance.
- Marking.
- Zero-power resistance at 25 °C.

10.8.2.3 *Requirements*

- No mechanical deterioration.
- Marking shall remain legible.
- Change of resistance between the initial measurement and the final measurement: in accordance with the detail specification.

APPENDIX A

INTERPRETATION OF SAMPLING PLANS AND PROCEDURES AS DESCRIBED IN IEC PUBLICATION 410 FOR USE WITHIN THE IEC QUALITY ASSESSMENT SYSTEM FOR ELECTRONIC COMPONENTS

When using IEC Publication 410 (1973) for inspection by attributes the following interpretations of the clauses indicated below apply for the purpose of this standard:

1. The responsible authority is the National Authorized Institution implementing the Basic Rules and Rules of Procedure.

1.5 The unit of product is the electronic component defined in a detail specification.

2. Only the following definitions from this clause are required:

— a defect is any non-conformance of the unit of product to specified requirements;
— a defective is a unit of product which contains one or more defects.

3.1 The extent of non-conformance of product shall be expressed in terms of per cent defective.

3.3 Not applicable.

4.5 The responsible authority is the IEC Technical Committee drafting the blank detail specification which forms part of the generic or sectional specification.

5.4 The responsible authority is the Chief Inspector, acting in accordance with the procedures prescribed in the document describing the inspection department of the approved manufacturer and approved by the National Supervising Inspectorate.

6.2 The responsible authority is the Chief Inspector.

6.3 Not applicable.

6.4 The responsible authority is the Chief Inspector.

8.1 Normal inspection shall always be used at the start of inspection.

8.3.3*(d)* The responsible authority is the Chief Inspector.

8.4 The responsible authority is the National Supervising Inspectorate.

9.2 The responsible authority is the IEC Technical Committee drafting the blank detail specification which forms part of the generic or sectional specification.

9.4 (Fourth sentence only.) Not applicable.
(Fifth sentence only.) The responsible authority is the Chief Inspector.

10.2 Not applicable.

APPENDIX B

RULES FOR THE PREPARATION OF DETAIL SPECIFICATIONS FOR CAPACITORS AND RESISTORS FOR ELECTRONIC EQUIPMENT

B1. The drafting of a complete detail specification by IEC Technical Committee No. 40: Capacitors and Resistors for Electronic Equipment, if required, shall begin only when all the following conditions have been met:

a) the generic specification has been approved;

b) the sectional specification, when appropriate, has been circulated for approval under the Six Months' Rule;

c) the associated blank detail specification has been circulated for approval under the Six Months' Rule;

d) there is evidence that at least three National Committees have formally approved, as their own national standard, specifications covering a component of closely similar performance.

Where a National Committee formally asserts that substantial or significant use is made within its country of a part described by some other national standard, this assertion may count towards the foregoing requirement.

B2. Detail specifications prepared under the responsibility of Technical Committee No. 40 shall use the standard or preferred values, ratings and characteristics and severities for environmental tests, etc., which are given in the appropriate generic or sectional specifications.

An exception to this rule may only be granted for a specific detail specification, when agreed by Technical Committee No. 40.

B3. The detail specification should not be circulated under the Six Months' Rule until the sectional and blank detail specifications have been approved for publication.

APPENDIX C

MOUNTING FOR MEASUREMENTS OF DIRECTLY HEATED THERMISTORS

C1. Mounting for thermistors without leads

Thermistors without wire terminations shall be pressed between phosphor-bronze wires of 1.3 mm ± 10% diameter, mounted on a base of insulating material, as shown in Figures 5 and 6.

Dimensions in millimetres

'imetres

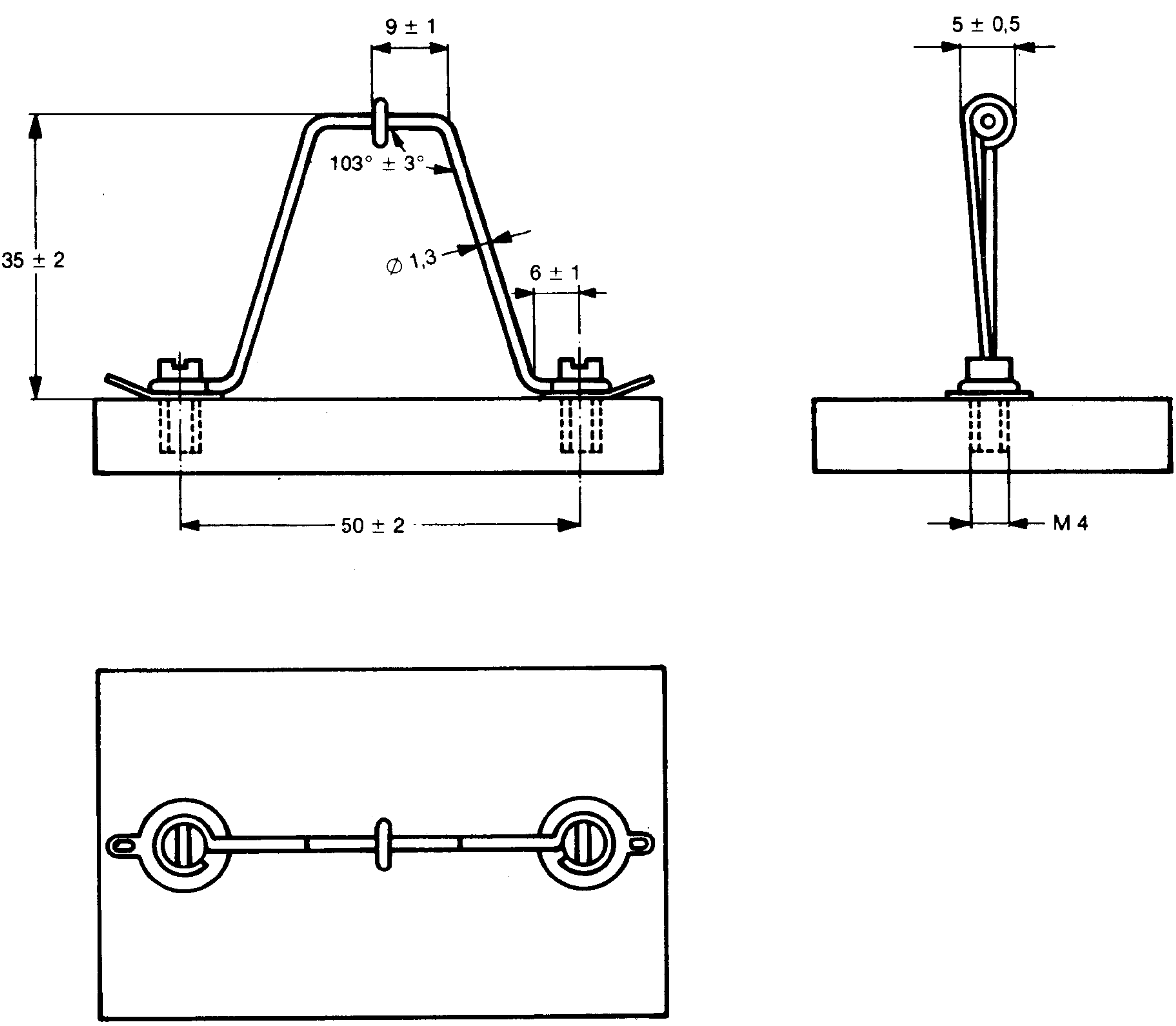


FIG. 5. — Mounting for values ⩾ 10 Ω (measurements with two contact points).

Dimensions in millimetres

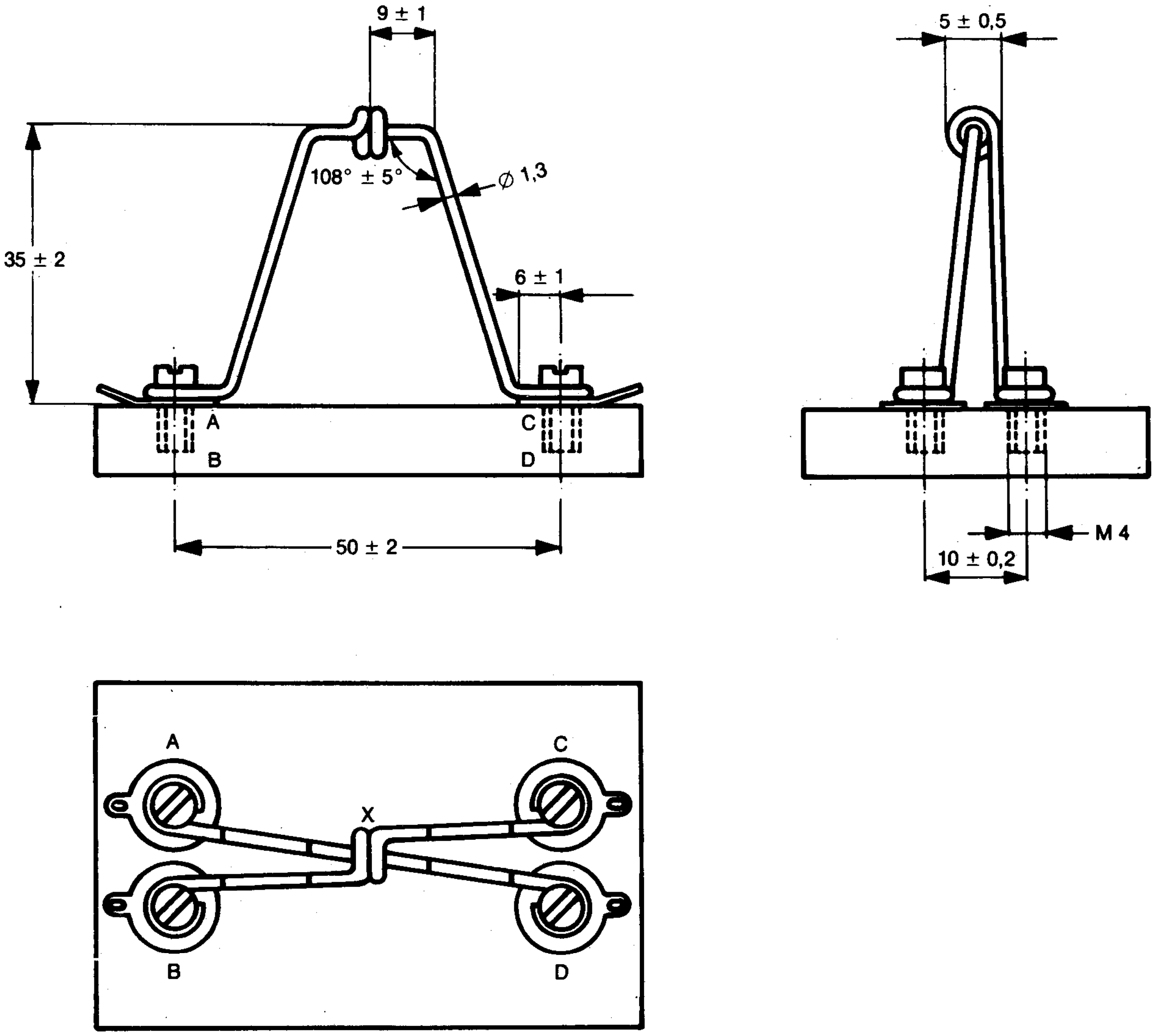


FIG. 6. — Mounting for values $< 10\ \Omega$ (measurements with four contact points)
The measuring voltage shall be applied via an ammeter to contacts A and D (or B and C) and the voltage drop shall be measured between contacts B and C (or A and D).

C2. Mounting for thermistors with leads

Thermistors with leads shall be connected (but not soldered) to phosphor-bronze wires of 1.3 mm ± 10% diameter, mounted on a base of insulating material, as shown in Figure 7.

Dimensions in millimetres

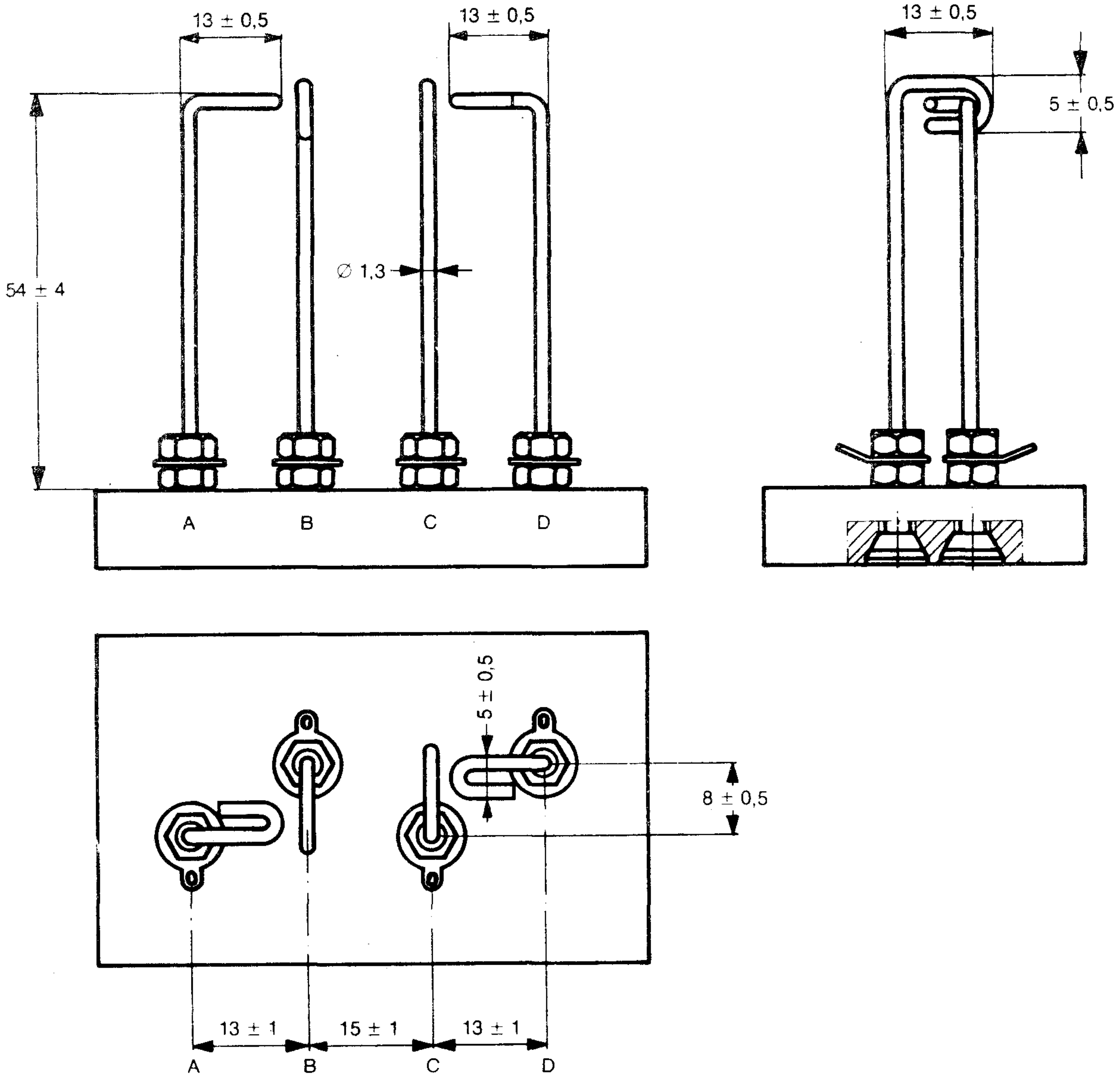


FIG. 7. — This mounting is suitable for measurements of high and low value thermistors
For thermistors of values ⩾ 10 Ω, contacts AC and BD or AB and CD may be used together.
For thermistors of values < 10 Ω, the measuring method with four contact points shall be used. The measuring voltage shall be applied via an ammeter to contacts A and D (or B and C) and the voltage drop shall be measured between contacts B and C (or A and D).